Revealing the Sociotechnical Complexity of Business Process Modeling – An Actor-Network Theory Approach

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ABSTRACT

In the last few years, the modeling of business processes has achieved considerable popularity in organizations and academic research. However, business process modeling is often studied from either a technical or a social perspective, and as a result of this *a priori* fragmentation, tends to overlook the sociotechnical complexity involved in modeling projects. To overcome this problem, this paper adopts an analytical approach based on the Actor-Network Theory, and performs a case study on a process-based quality management project in a large aircraft maintenance company. The results of the case analysis show that the form and meaning of both the process models and organizational routines are negotiated by setting up sociotechnical networks in modeling projects, thus making it clear that process models and 'non-technical' issues co-constitute each other. In this way, the paper provides an analytical tool that can help unravel the sociotechnical complexity involved in process modeling.

Keywords

business process modeling, organizational routines, actor-network theory, flexibility.

INTRODUCTION

In recent decades, the concept of the business process has become widespread as a basic construct for structuring organizational work in conjunction with information systems. The main advantage of the process-based approach is that, from a customer-oriented perspective, it enables a company to overcome the problem of having the workflow broken up into different functional divisions. This can allow the activities of an organization to be geared towards end-to-end flows (Melao & Pidd 2000, Weske 2007).

While its roots can be traced back to the total quality management initiatives of the 1970s and 1980s (Smith & Fingar 2003), the process-based approach attracted a good deal of attention in the 1990s, when radical business process re-engineering was linked to Enterprise Resource Planning systems (Hammer 1990). As a result – and, particularly, following the failure of a large number of projects – in recent years there has been a so-called "third wave" of Business Process Management (BPM) (Smith & Fingar 2003). One of the core activities of these BPM projects is the modeling of business processes in the form of diagrams, which is mostly carried out by using a graphical, activity-based notation. These diagrams define and formalize the activities of a process and their mutual relations, in a way that allows the established activity sequencing to be subject to restrictions on the social practice of organizational routines.

Since business process models often serve as a basis for automation which is operated by different types of computerized information systems (e.g. Enterprise Resource Planning, Business Process Management Systems), they thus form the missing link between both the social world of organizational routines, and the technical world of Information Technology artifacts. Being a hybrid, sociotechnical object *par excellence*, business process models are often studied either from a technical perspective (e.g. for the definition of workflow methods and software tools), or a social perspective (e.g. in the study of organizational routines). However, this *a priori* fragmentation of the process modeling into technical and social issues is not able to grasp the sociotechnical complexity that arises from the constitutive intertwining and co-evolution of the postulated social and technical worlds, i.e. their "sociomaterial entanglement" (Orlikowski, 2007).

To address these questions, an appropriate theoretical basis is needed that can make the relationship between business process models and organizational routines intelligible. In pursuit of this goal, this paper adopts a qualitative approach that involves drawing on theories derived from Science and Technology Studies and known as the Actor-Network Theory (ANT) (Akrich 1992, Callon 1991, Latour 2005). These have already been used in the field of Information Systems (e.g. Hanseth et al. 2004) but not yet in the context of business process modeling. Moreover, they have the advantage of providing a theoretical

basis for a symmetrical analysis of the contributions made by human and non-human entities. In this paper, the ANT analytical approach is adopted to unravel the sociotechnical complexity involved in business process modeling. This is accomplished by means of an empirical study of an integrated quality management system (based on business process modeling), within a large aircraft maintenance corporation.

The remainder of the paper is structured as follows: the next section outlines the theoretical underpinnings of the research, and defines the main concepts of the Actor-Network Theory. Then there is an outline of the research design and the methodology employed. Following this, the case study is described, and then analyzed and discussed. Lastly, we make some concluding remarks on the paper and make recommendations for further research.

THEORETICAL UNDERPINNINGS: FORMAL MODELS, ORGANIZATIONAL PRACTICES AND FLEXIBILITY

In analyzing the relationship between business process models and organizational flexibility, account should be taken of how these models are related to organizational work practices. Business process models are often conceptualized as portrayals or representations of patterns of behavior in the organization, called business or organizational processes. Although they have a distinctive connotation that is derived from the "process view" mentioned earlier, processes can be basically seen as organizational routines. In fact, although the terms "process" (Lindsay 2003) and "routines" (Becker 2004) are used in the literature in an ambiguous way, both are generally associated with recurring patterns of behavior that are embedded and anchored in the organization. Recent research work has emphasized the dynamic character of organizational routines (Cohen 2007, Feldman & Pentland 2003, Pentland & Feldman 2008); since they are human practices, they must be carried out in a continuous way to allow routine activities (or processes) to be undertaken and thus enable variations and changes to occur.

In fact, the relation between formal models and work practices has been the focus of a large number of research studies during the last few years. As Berg (1997) points out, it is commonly assumed that there is a sharp contrast between "dead" formal artifacts – which are usually regarded as abstract, homogeneous, and symbolic – and "live" human actions – whose messy, dynamic and contingent character can never be entirely mapped into formal artifacts. If this is transposed to the organizational domain, on the basis of the separation proposed by Pentland and Feldman (2008), one must distinguish between formal, "dead" business process model artifacts and the represented informal, "live" business process (or organizational routines).

An underlying assumption in this line of reasoning is that formal process models and enacted business processes belong to distinct and detached domains of reality: whilst the former are affiliated to the technical realm of mechanical determinism, the latter form a part of the living world, the locus of human agency and interpretation. It should be stressed that, although this dichotomy into two ontological categories tends to be implicitly assumed rather than explicitly theorized, it has practical implications. From this standpoint, organizational flexibility, for instance, must be regarded as an exclusive attribute of the social, human domain of processes and routines (Feldman & Pentland 2003), whereas since models are elements of the formal world, they are impoverished representations of these processes. In view of this, process models are rigid by their very nature.

In recent decades, academic research in the field of Science and Technology Studies (STS) has challenged the ontological dichotomy between the social and material (or technical) world. It has been argued that this essentialist view is unable to deal with the complexity of the situation found in practice, where human activity is closely intertwined with technical and formal artifacts (Barad 2003, Latour 2005, Suchman 2007). In fact, the reification of "essential properties" in both formal artifacts and human activities conceals some of the implicit and necessary counterparts from the "other side", such as the "configured" human behaviors that are implied in the deterministic workings of the artifacts (Woolgar 1991), as well as the constitutive role played by material artifacts in social relations (Latour 2005). Moreover, as a result of the entanglement of formal artifacts and human actions, "new competences for workers can be achieved, higher levels of complexity in work tasks can be reached, and activities can be coordinated over time and place" (Berg 1997). Recently, works in the field of organization studies have echoed these notions; it has been argued that the relationship between technology and organizing practices can be more clearly understood if we question the validity of the ontological dichotomy between the "social" and the "material" and recognize the significance of materiality in organizational practices (Orlikowski 2007, Leonardi & Barley 2008).

On the basis of the insights found in these studies, we argue that the ontological premise that underlines the essential dichotomy between "live" process (on the social side) and "dead" artifacts (on the material side), fails to take account of the constitutive character and generative power that business process models may have in practice.

From "Dead" Artifacts to Actor-Networks

The Actor-Network Theory (ANT) is able to overcome the problem examined above by relying on heterogeneous, socio-

technical arrangements called socio-technical ensembles, hybrids, or actor-networks (Callon 1986, Latour 2005, Law 1992) as units of analysis. These hybrid entities comprise both human and non-human 'actants' – a word borrowed from semiotics to refer symmetrically to human and non-human actors (Akrich 1992) – such as people, texts, concepts, machines and so forth. However, the symmetry in the analytical stance adopted by ANT should not be confused with the proposition that there is a complete equivalence between humans and non-humans. It must be taken into account in the context of a relational ontology that does not take for granted that there are a priori divisions between technical and social elements (McMaster & Wastell 2005).

From the standpoint of ANT, the formalization of organizational practices into models of business processes can be seen as the knitting together of a heterogeneous network which is then black-boxed into a hybrid quasi-object (Latour 2005), i.e. a relatively stable set of relationships is created around the model artifact that is put into circulation. The enrolment of different actors to form a relatively stable network of alliances is known in ANT as 'translation'. It should be underlined however, that the relative stability of the relations that are "black-boxed" in the model network cannot be guaranteed, but should be seen as a precarious and uncertain achievement that has to be continuously enacted in organizational practices (Law 1992). Thus a distinctive feature of the ANT perspective is that the model as an actor-network cannot be said to exist "outside" of the network, because the model constitutes and at the same time, is constituted by the network of relationships with the other actors. Hence, the terms actor, actor-network, and actant can be employed interchangeably (as they are in this work). This corresponds to the "constitutive entanglement" between the 'material' and the 'social' recently advocated by Orlikowski (2007).

As pointed out by Pickering (1995), this perspective implies moving from a 'representationalist' idiom to a performative one. This entails a shift from viewing process models as (impoverished) representations of organizational practices, to considering the model artifacts and their putative properties (e.g. rigidity, formality, durability etc.) as ongoing achievements in the performances of the network relations. In this way, the form and meaning of the models emerge from negotiation processes between all the actants involved (Akrich 1992).

From this perspective, by relying on the analytical perspective of the ANT approach, our main goal in this paper is to make the sociotechnical complexity involved in business process modeling intelligible.

RESEARCH DESIGN AND METHODOLOGY

This paper discusses the relationship between the business process models and organizational routines, in the context of business process modeling projects. Owing to the exploratory nature of the study and the breadth of its scope, we decided to adopt a qualitative and interpretive approach (Walsham 1993) to address the key research question: how can we make sense of the sociotechnical complexity involved in business process modeling?

This question is analyzed by means of a case study that involves a process modeling project. This was embarked on five years ago and was carried out within the quality management department of a large-scale aircraft maintenance company in Germany (henceforth called AMC). The aim of this paper is thus to analyze a case based on practice, identify plausible results, and explain the phenomena observed by drawing on resources from the actor-network theory. On the basis of Walsham's (1993) typology, the main objective of this paper is thus to provide a more comprehensive understanding of the relation between business process models and organizational practices in business process modeling projects.

Data Collection and Analysis

The data were gathered by means of semi-structured interviews (that were concerned with the historical background and reasons for undertaking the project), as well as from observation carried out in several modeling workshops. The sources of information for this research include the following: (1) the interviews with some of the process modelers, one of the heads of the project and a member of the quality management team, (2) notes taken during the observations on some of the modeling workshops, (3) printed documents and manuals for instructing employees about new features and how to use the software tool, (4) official internet information about the company, (5) the official environmental statement of AMC, (6) e-mails – additional questions came up during the evaluation of interviews and these were answered via e-mail by three process modelers.

The data was collected over a period of about two years and this was only terminated when we felt that we had a complete data snapshot for the case and research question. While the data was being collected, a preliminary analysis that involved interaction with the subjects was conducted to provide guidance on other issues that had to be addressed during the fieldwork (Klein & Myers 1999). The analysis of the information collated, was carried out through the intersection and triangulation of the data. This was examined in the light of the theoretical framework outlined above so as to identify phenomena and obtain

new understandings and insights that were relevant to the research. Thus, the first step of the analysis process consisted of an codification of the data with the goal of identifying the actor-networks involved in the process modeling, according to the method of "tracing the associations" proposed by Latour (2005). Based on the identified actor-networks, the collected data was then interpreted in order to make sense of the sociotechnical complexity involved in the modeling workshops, by examining the inter-relationships between process models and organizational practices.

DETAILED DESCRIPTION OF THE CASE STUDY

AMC has about 20,000 employees and forms a global network with its affiliates and subsidiaries. As explained by the head of the quality management department, a technical failure during the take-off of a plane triggered a change in the company's Business Process Modeling (BPM) project, which is analyzed below. It was this incident that led the quality management department to decide to re-organize and re-establish the existing quality management system. Up to this time, quality management had been regarded by people in AMC as simply an inconvenient requirement of the aeronautical authorities. The company had a repository of various interrelated documents such as operational instructions, safety instructions, and environmental requirements, as well as guidelines for quality management. These were designed to ensure the maintenance of standards at work, but basically consisted of lengthy documents and a wide array of diagrams – all of which were identified as the main cause of failures. Different business units had compiled these documents, each using its own language and particular definitions of processes and roles. As a result, before it was possible to trace a business process that ranges over several business units, it was necessary to read a large number of documents with various graphical notations, different formats, and a divergent use of terminology. Thus, it should not come as a surprise that these documents were rarely used.

The Quality Management Project (QMP) was carried out on a national level for about five years to improve standards and make business processes more transparent and easier to manage. It was aimed at gradually modeling the business processes of each business unit, so that all the processes could be combined in a corporation-wide, easy-to-use process map. The expectation was that these could be used by employees to enable them to visualize the processes – and thus be able to dispense with the old text-based documents and non-standardized diagrams.

Modeling workshops: mobilizing and inscribing

The modeling of business processes was carried out in workshops and conducted by a modeler from the quality management department with up to ten (mostly three to six) employees as representatives of their business units, e.g. repair personnel (on the shop floor), lawyers (legal department) and traders (sales and insurance departments). The representatives were interviewed by the modeler about the most important activities carried out, decisions made, and data used in their daily work. On the basis of their answers, the models were designed in an interactive way while being projected on a big screen. Each modeling session took up to three hours, and at the end, all the modeled processes were shared among the participants (by e-mail) for a final inspection and feedback. If necessary, the participants would agree to meet again at another modeling workshop to improve or change the model.

Reverting to the ANT vocabulary, it can be said that the employees of a certain business unit are 'mobilized' (Callon 1986) through the representatives that act as their spokesmen in the modeling workshops. The representatives are thus expected to file a report on the work practices of all the absent employees they are representing, whereas these absent employees are expected to accept the outcome of the negotiations that take place in the modeling sessions, and effectively (re)adjust their practices in accordance with the models that are finally produced. Of course, these assumptions must hold true in practice for the enrolment (Callon 1986) of the actors to be successful.

With the introduction of the process-based modeling tool in QMP, each business unit now had to appoint someone to play the role of the process owner, with the following responsibilities: (a) to control and (b) regularly update the processes of the corresponding business. The final versions of the process models are then inspected by the process owners, who decide whether the processes are correct and ready for the final 'conformity check'. In this way, the employees of the quality management department check the extent to which the process complies with the requirements laid down by the aeronautical authority. Once this last check has been carried out, the process is integrated into the "repository" (process map) and "goes live" – i.e. it becomes publicly available and can thus be accessed by all the employees of AMC.

In this process, the figure of the process owner acts as a key component for achieving the "enrolment" of the represented employees. As mentioned above, before QMP was started, there was no conception of "business processes", and the existing disconnected operation instructions and diagrams were mostly (whether consciously or not) ignored by the employees. With the employment of QMP and the modeling formalism, the assignment of an owner for each process – which has already been inscribed into the modeling technique – is mandatory. The process owner is thus responsible for the accuracy of the process model, which entails both ensuring that the model reflects the work practices and seeing that everybody's practice actually

complies with the model.

Negotiations and conflicts: inscribing organizational practices

During the modeling sessions some interesting discussions took place among the employees – and some unexpected incidents occurred. During the interactive modeling and visualization of the models, the work processes, roles, and hierarchies had to be described in detail. This caused disagreement among the employees about certain aspects of the activities being modeled, such as: (i) who should execute them and the identity of the process owner (with responsibility for conflicts), (ii) who else is involved and why (interface conflicts), (iii) in a sequence of activities, who should be first and why (role conflicts)?

What we see here is negotiation about the shape of the organizational practices and the 'inscription' (Akrich 1992) of these practices into formal artifacts, i.e. the process models embody and prescribe determined associations of the elements in the organization. These elements included people, tasks and the relationship between them – which are respectively represented in the models by roles, activities and sequential links.

Thus, although no radical restructuring of the organization (like a "big bang" business process re-engineering) was being put into effect, the organizational form – that is the practices that give shape to the organization – was being renegotiated and remodeled. The different actors (or groups, or units) had different sets of practices, which gave rise to different, co-existing organizational forms. However, in the modeling, these practices were confronted and some of them were found to be incompatible and full of conflicts.

Until then, these "conflicts" had been dealt with on an individual basis and informally (whenever they occurred), to the extent that they were not actually identified as conflicts per se. But now, as a result of the visualization provided by the graphical representation, an "official" version was being produced, and the actors involved in the modeling (the unit representatives and the modeler) struggled to have their "versions" of the organizational practices translated into process models. Clearly, this was directly connected with the position that the process models have in the QMP network. In the context of QMP, the process models are expected to act as guidelines for future organizational practices. On the basis of the ANT concept of prescription (Akrich 1992), it could be said that the models inscribe *organizational prescriptions*, i.e. they prescribe certain organizational orderings. As a result of the negotiation, it can thus be said that each modeling session builds a network around the business process model obtained, by aligning the actors involved and 'translating' their interests. The network corresponding to the whole project (QMP) can be seen to arise from the agglutination of the networks involved in each business process.

More conflicts and betrayal

Interestingly, not only the "contents" of the models but also the formal modeling notation has been a subject of controversy. These conflicts occurred in the modeling of processes that had an inter-organizational character and were connected to different business locations. The processes are critical because they prescribe the way that data and activities are passed from one location to another. In the modeling technique adopted, this relation is represented by an arrow that goes from the sender to the receiver. When modeling these processes, the representatives of different units interpreted this notation as defining a hierarchical relationship between the business locations involved. The sender location was ranked higher, since the receiver was "dependent" on the given data and thus had to conform to the activities carried out by the sender.

As a result, there was a conflict in the modeling sessions between two different possible arrangements (or programs of action) involving the notation. The modeling formalism incorporated in the tool pressed for a separation between a process-oriented description of activity sequences (represented by process models) and the hierarchical organizational structure (shown in the organization charts). This suggests that the arrows between the sender and receiver had sequential, non-hierarchical links. The arrangement was inscribed in the tool and supported by the modeler during the sessions. It could thus be said that the quality management department - "punctualized" (Law 1992) as the modeler actor - subscribed to the prescription that was inscribed in the formalism (Akrich 1992). On the other hand, the employees regarded the use of this notation as an opportunity to translate a form of hierarchical superiority into the process model. This gave rise to a lively argument over the order of precedence of the activities that each of them carried out. In this way, this example shows that even formalism itself can be enrolled into a network (i.e. incorporated in practices) to serve interests other than those for which it was originally designed and thus betray them – i.e. the artifact is then de-inscribed (Akrich 1992).

CONCLUSION

This paper has employed an analytical approach based on the Actor-Network Theory (ANT) for analyzing the sociotechnical complexity of business process modeling. This approach was able to offer insights about the different sociotechnical

imbrications involved in the modeling of work practices in process models, in the context of a comprehensive quality management project that relies on business process modeling in a large-scale aircraft maintenance company.

The results of this analysis clearly show that our symmetrical ANT-based approach goes beyond usual approaches that set out from an *a priori* dichotomy between social and technical issues. When we regard process models within the sociotechnical networks of model development and use, it is clear that the putative 'technical' and 'social' issues are inextricably intertwined, so that models and 'non-technical' elements co-constitute each other within the continuous movements of organizational practices.

With regard to our analysis of the modeling workshops, we are able to see that the form and meaning of the models are derived from the negotiation processes that take place between all the actors (human and non-human) involved. On the one hand, the achieved models inscribe intentions, prescriptions of organizational forms, interests and worldviews – thus helping to configure the organizational space in which they are used. On the other hand, in the organizational practices, the model elements (and even the notation formalism) are combined with elements that are different from those which were originally anticipated – thus altering the very meaning and significance of models.

In view of this, it can be seen how an analysis based on ANT, can act as an important resource to process modeling projects. A possible further application of this analytical approach might be in the area of typical sociotechnical issues such as the flexibility brought about by process modeling. Flexibility cannot be analyzed by only taking account of the properties of the isolated 'technical' and 'social' elements involved, since it consists of an emergent property of the sociotechnical networks that are engendered from these elements. In this context, our ANT-based approach makes it possible to understand flexibility in business process management projects by making it possible to analyze the associations that compose the sociotechnical networks around the process model.

The practical use of the ANT perspective requires a careful analysis of a project to identify the sociotechnical networks involved and instill an awareness of the implications of the relations established by its various elements. In this way, the relevant sociotechnical implications in a particular project can be identified. This type of analysis is clearly a further step towards revealing the socio-technical complexity involved in process modeling, an area that has often been ignored and not consciously reflected on, in conventional technically-oriented approaches. Only a process modeling practice that is aware of the effects that emerge from the models within the associated social practices, will be capable of identifying and dealing with their sociotechnical implications in an appropriate manner.

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